

Emulated Networks for Clouds in BonFIRE

Gregory Van Seghbroeck, Tim Wauters, Filip De Turck, Piet Demeester

Ghent University - IBBT, Department of Information Technology,
Gaston Crommenlaan 8 bus 201, B-9050 Gent, Belgium

Abstract. Although cloud systems mainly focus on management solutions for computing resources, implications from the networks interconnecting these resources have to be taken into account as well. The Virtual Wall emulation testbed in BonFIRE allows for large-scale experiments to test the influence of various networking parameters on cloud-based solutions, including topology, link delay, bandwidth, packet loss and background traffic.

Keywords: Future Internet Research and Experimentation, cloud, network

1 Introduction

The Virtual Wall in IBBT is a network emulation facility based on Emulab software and allows for controlled networking experiments. It consists of 100 nodes, each with 4 cores, 4GB RAM and 4 to 6 Gigabit Ethernet interfaces, interconnected by a non-blocking switch. Within the BonFIRE project, the Virtual Wall has been integrated (shown in Fig. 1) in the multi-site cloud testbed that aims to offer large-scale testing for the Internet of Services community over heterogeneous resources.

BonFIRE offers a centralized federation that allows the deployed experiments to use resources across all testbeds. The different testbeds communicate over a secure and private network, called the BonFIRE WAN. Management and operation requests are handled by the BonFIRE Resource Manager, providing a uniform view on the heterogeneous testbeds. Incoming requests are transformed by the Enactor into testbed specific commands, shielding the technicalities of managing the different resources. BonFIRE created numerous methods to make it easier for the experimenters to define and manage their experiments, e.g. the Portal (a GUI-like wizard), the Experiment Manager (capable of managing the deployment and execution of an experiment described in OVF or in a proprietary JSON format), and Restfully (a Ruby extension, which allows to script the creation of an experiment and its resources). These modules all talk to the Resource Manager using the BonFIRE API. Next to this BonFIRE offers a highly controllable monitoring framework (supported by Zabbix) at both the experiment and the infrastructure level.

The BonFIRE API is based on the standardized Open Cloud Computing Interface (OCCI). This RESTful API allows to create, read, update and delete resources (CRUD) defined in the OCCI's Infrastructure Model: Compute, Storage and Network. An important extension provided by BonFIRE is the addition of a high-level contain-

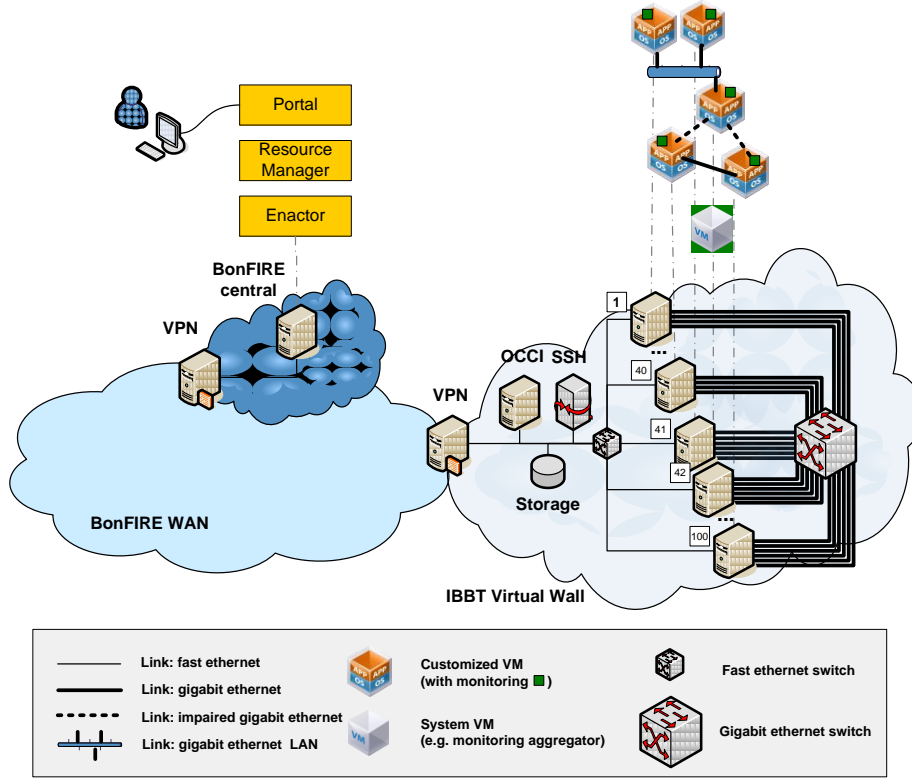


Fig. 1. Integration of IBBT's Virtual Wall in BonFIRE.

er, the Experiment, which aggregates different resources required to execute a particular experiment. This opens up new management capabilities, e.g. starting and stopping all resources from a single experiment, and advanced operational aspects, e.g. easier scheduling and reservation jobs.

2 Virtual Wall features

Although the Virtual Wall is not a typical cloud environment (e.g. it lacks the ability to dynamically add Computes to an already running experiment), its functionality offers a first step to bridge the gap between network and cloud experimentation. The Virtual Wall therefore implements the same OCCI resources as the other testbeds collaborating in BonFIRE. How it implements these resources is very different due to its underlying framework, Emulab. For instance, the Virtual Wall maps Compute resources to physical nodes, which allows the experimenter to take full control of the hardware. Experimenters can create two kinds of Computes: monitor aggregators, used for BonFIRE's rich monitoring capabilities, and an enhanced Debian server, which fully integrates BonFIRE's management and monitoring layers.

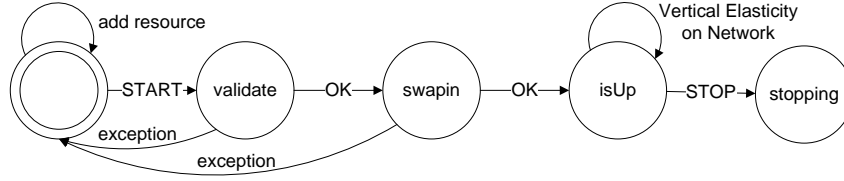


Fig. 2. Simplified overview of the sub-experiment’s state handling in the OCCI Service.

The standard OCCI Storage resources are not virtualized either. The Datablock Storages are mapped to real disk partitions on the physical node, which makes accessing these storages very fast and straightforward. In response to the need of experimenters to share larger amounts of storage between different Compute resources, the Virtual Wall implements a notion of shared storage based on the Network File System (NFS), accessible from the BonFIRE WAN by any Compute instantiated in one of the BonFIRE testbeds.

Whereas the other BonFIRE testbeds only provide a best-effort variant of the Network resource, IBBT’s Virtual Wall implements three different types of Network resources: Default Networks that provide basic connectivity between two or more Computes, Managed Networks that provide controllable QoS (Parameters that can be adjusted are bandwidth, packet lossrate and delay) over the network links, and Active Networks, that, on top of the functionality of Managed Networks, also provide the possibility to control the background traffic (UDP and TCP connections with adjustable packet size and throughput) on a network link.

3 Virtual Wall integration in BonFIRE

The Protocol adopted by OCCI is request-based, i.e. Create and Delete requests can easily instantiate or remove Compute resources in the cloud. Unfortunately, this level of horizontal elasticity is not possible in the Virtual Wall, where all resources have to be configured in advance and deployed at once.

To bridge the gap between OCCI’s request-based Protocol and the way the Virtual Wall deploys an experiment, CRUD requests are grouped in the Virtual Wall’s OCCI service (Fig. 2). Benefiting from the management capabilities of the high-level Experiment container, the experiment can then be started by transforming it to NS2 and validating it by the Emulab software. On success, the resources can be allocated and deployed if sufficient resources are available on the Virtual Wall, and swapped out when the Experiment’s execution time is exceeded. Vertical network elasticity, the ability to dynamically change virtually every characteristic of the network interconnecting the Compute resources deployed on the Virtual Wall without having to stop the experiment, is supported through OCCI Update requests on the Network resources.

Acknowledgement. BonFIRE is funded by the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement numbers 257386 and 287938.